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Article

Self-Governance and Sustainable Common Pool Resource Management in Kyrgyzstan

Tanja Baerlein [1,†], Ulan Kasymov [2,†] and Dimitrios Zikos [2,†,*]

[1] HTW Berlin—University of Applied Sciences, Treskowallee 8, Berlin 10318, Germany; E-Mail: t.baerlein@gmail.com

[2] Division of Resource Economics, Humboldt University Berlin, Hannoversche Str. 27, Berlin D-10115, Germany; E-Mail: ulan.kasymov@agrar.hu-berlin.de

[†] These authors contributed equally to this work.

* Author to whom correspondence should be addressed; E-Mail: dimitrios.zikos@agrar.hu-berlin.de; Tel.: +49-(0)-30-2093-46377.

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Abstract: How to best govern natural resources in order to enable a sustainable way of handling them is what both research and practice aim to achieve. Empirical findings from several studies indicate that resource users are able to successfully cooperate in the management of common pool resources and solve social dilemmas through self-governance arrangements. The authors explore the potential success of self-governance in irrigation systems, focusing primarily on the factors influencing compliance of irrigation water users under self-crafted and self-enforced rules in two Kyrgyz communities. A field experiment is employed to provide insights and some quantitative empirical data, further complemented by qualitative methods (questionnaires, group discussions and interviews) to enhance the analysis of the findings about working rules in irrigation at the community level. The results show that Kyrgyz irrigation users of the selected communities generally respond better in a self-governance setting in terms of rules compliance, distribution efficiency and equity. Compliance and cooperative behavior depend on group as well as individual variables including communication, social norms and the legitimacy of rules.

Keywords: common-pool resources; sustainable water management; field experiment; Kyrgyzstan

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1. Introduction

A highly debated topic in the literature and among scholars, practitioners and politicians concerns finding a "panacea" to guarantee the sustainable management of diminishing natural resources, *i.e.*, to protect them from overuse and safeguard their social, environmental and economic viability in the long-run. Influenced by Hardin's [1] "Tragedy of the Commons"—a dooms-day scenario suggesting the inevitable destruction of resources used in common (or better in a *free access* situation)—as well as numerous cases of overused and depleted resources worldwide, many policy makers and public administrators advocate for centralized control over natural resources. They argue that government intervention could solve the "tragedy" by restraining users' extractions through regulations and enforced sanctions [2]. Others argue in favor of privatizing valuable resources by assigning property rights, thus transforming the resources into private goods and solving the "tragedy" through access restriction [2]. As experience shows, both methods can be effectively used under certain circumstances, although such conditions are not always fulfilled in practice. Furthermore, the suggested approaches are often too simplistic to include the dynamics of resources falling into the category of common-pool resources (CPRs). In contrast, groups devising their own local institutions for CPR management have been empirically proven quite successful. Such institutional arrangements often appear in cases of self-management of resources by local users, and includes the design and enforcement of rules based on collective action [3–5].

The classification of goods, upon which different approaches for achieving sustainable management of natural resources rely, is based on two basic principles: rivalry of consumption (also referred to as "divisibility of benefits" or substractability) and excludability. Rivalry is broadly understood as competition between individuals or groups for the use of the same limited resource *i.e.*, if one individual consumes the good, consumption opportunities for the same good diminish for other individuals (e.g., fish). Conversely, non-rival goods can be consumed without affecting another person's consumption utility and thus are indivisible (e.g., observing a sunset). Excludability on the other hand refers to the degree that it is possible to prevent an individual or group from consuming a good and deriving benefit from it in case of not-being granted access (e.g., not paying for cable TV). If the exclusion is impossible and/or very costly, the good and its benefits are available for everybody once it is provided; it is subsequently considered not-excludable (e.g., an individual cannot be excluded from watching fireworks) [6,7] (pp. 221–234).

As illustrated in Table 1, common goods or CPRs are non-excludable natural (biological) or human-constructed (physical) resources such as pastureland or roads, which differ from the pure public goods in rivalry [8].

Given that the exclusion of beneficiaries from public and common goods is either costly or technically impossible, people have the incentive to free-ride. A free-rider benefits from the good without paying the cost of its provision. In the case of CPRs, additional problems of distribution and overuse arise due to the rivalry in consumption. Given that the exploitation of resources of one individual reduces the resource availability for others, thus presenting a negative externality, the resource tends to be used excessively. Ostrom [9] notes that overusing a CPR can lead to its degradation, congestion and/or destruction, thus confirming indeed Hardin's paradigm. Natural resources are particularly prone to this problem given their scarcity and the situation of an ever-increasing population [9].

Table 1. Classification of goods.

		Consumption	
		Rival	**Non-Rival**
Excludability	feasible	**1. Private goods:** - Fuel - Food	**2. Club goods:** - Cable TV - Cinemas
	not feasible	**3. Common goods:** - Fish grounds - Bridges	**4. Pure public goods:** - National defence - Fireworks

Source: own illustration based on Mankiw and Taylor [7] (p. 222).

Various types of CPRs exist that can be differentiated due to (i) their provision; (ii) their physical characteristics; (iii) their types of use and (iv) their ownership. Firstly, CPRs can be provided by nature (e.g., pastures) or constructed by humans (e.g., roads). Because natural CPRs already exist, there is no need to collectively organize their provision. However, man-made resources have to be constructed and maintained. Secondly, CPRs are renewable (e.g., fish stocks) or non-renewable (e.g., minerals), stationary (e.g., lakes) or non-stationary (e.g., migratory fish) and/or symmetric (e.g., lake) or asymmetric (e.g., irrigation channel) [8,10]. Thirdly, CPRs can be used locally or globally; for example, a city bridge is used locally while the Internet is used worldwide. Furthermore, CPRs can be used to derive a direct advantage (e.g., catching fish for nutrition), while others are utilized to absorb or mitigate undesirable effects (e.g., the atmosphere absorbing greenhouse gases such as CO_2, which are emitted while using fossil fuels). Finally, Ostrom [9] (p. 249) claims that "[CPRs] may be owned by national, regional or local governments, by communal groups or by private individuals or corporations" and thus managed under varying property rights regimes [9,11].

Main aim of this paper is to explore empirically the current working rules in the irrigation water management and some of the proposed necessary conditions for the success of CPR management at the community level. The authors pursue this aim by structuring the presented research around the leading question of *whether resource users will present a higher level of compliance for the self-designed than the exogenously designed rules and why*.

Accordingly, Section 2 of the paper introduces institutions as viewed from an institutionalist perspective and the key concepts of CPR management. It further identifies several theoretical propositions to be empirically explored. Subsequently, Section 3 presents the employed methods to be applied in the described case study. Empirical findings are presented and discussed in Section 4 of the paper. The overall results and the limitations of the study are summarized in the concluding Section 5.

2. Common Pool Resource Management and Institutions

2.1. Institutions as Social Constructs Defining Choices

Within institutional economics, several schools of thought have emerged. Hodgson [12] (p. 2) defines institutions "as a system of established and prevalent social rules that structure social interactions". Brousseau *et al.* [13] (p. 4) distinguish between formal and informal institutions suggesting that informal institutions are spontaneous and formal institutions are designed. Hodgson [12] on the other hand, agrees about the importance of the informal rules, but opposes a sharp distinction between the formal and informal institutions. He claims that formal institutions always depend on the non-legal rules and inexplicit norms and that "ignored laws are not rules" (*ibid*: p. 6). He argues that such sharp distinctions can lead to confusion: "if formal rules means legal, then it is not clear whether "informal" should mean illegal or non-legal, even if they writing down (*i.e.*, not expressed in the law)" (*ibid:* p. 11). He suggests distinguishing between explicit and tacit, designed and spontaneous institutions in order to be sufficiently clear. The New Institutional Economics (NIE) school largely adopts the definition of institutions given by North [14] (p. 3) for whom institutions "*are the rules of the game in a society, or more formally, are the humanly devices constraints that shape human interaction*". Institutions are then seen as external constraints for the individuals, whose goal is to maximize their utility. Institutions-as-equilibria move a step further and see institutions as spontaneously formed within a game, players are invested in. There is no role for the collective and no intention in the formation of institutions. They are mutually accepted by all players and there is hence no need for the state to establish or control them [15].

Crawford and Ostrom [15] distinguish further between institutions as "equilibria", as "norms" and as "rules". The "equilibria" approach focuses "on the stability that can arise from mutually understood actor's preferences and optimizing behavior" and this stable pattern of behavior are understood as institutions [15] (p. 582). Institutions as "norms" on the other hand is based on the assumption that shared perceptions among a group of actors on what is considered proper and improper behavior creates certain patterns of interaction. Consequently, institutions viewed from this perspective, focuses more on the shared beliefs of a group. Finally, institutions as "rules" assumes that "many observed patterns of interactions are based on a common understanding that actions inconsistent with those that are prescribed or required are likely to be sanctioned or rendered ineffective if actors with the authority to impose punishment are informed about them" [15] (p. 583). Hodgson [12] however notes that in NIE there is an on-going debate concerning whether institutions should be regarded as "equilibrium", "norms" or "rules".

For Classical Institutional Economics, the collective is important and institutions are not constraints, but rather *enablers* of realms of choice. For Commons [16] institutions are legal relations (a) between individuals and (b) between individuals and the state. Bromley [17] (p. 22) defines institutions as "*rules and conventions of society that facilitate coordination among people regarding their behavior*". For classical institutional economics, institutions are purposefully constructed by the collective with the purpose of altering interactions between members of a going concern.

Vatn [18] agrees with Commons and Bromley when he sees institutions as socially and purposefully constructed. He offers a typology of institutions according to their form and their motivation. Institutions are thus "*the conventions, norms and formally sanctioned rules of a society. They provide expectations, stability and meaning essential to human existence and coordination. Institutions regularize life, support values and produce and protect interests*" (*ibid*: 60). Conventions (like language) address and simplify simple coordination problems. Norms differ from conventions in their incorporation of values. Norms are socially created and internalized rules to define and support values in a situation with conflict potential. The last category, formally sanctioned rules combine *i*. an act which is either allowed or forbidden with *ii*. an agent or a system with sanctioning authority. This third category is referred to by Commons [16] and Bromley [19] as legal relations and their purpose is to create order and resolve conflicts. These legal correlates define what individuals "must or must not do (duty), what they may do without interference from other individuals (privilege), what they can do with the aid of the collective (power) and what they cannot expect the collective to do in their behalf (no right)" [17] (p. 43).

Another view on institutions is given by Crawford and Ostrom [15] who see institutions as regularized patterns of human behavior, shared norms, rules and strategies. Institutions (let them be conventions, norms or formally sanctioned rules) include the so-called ADICO: an attribute, a deontic, aim, conditions and sanctions. Attributes defines who the rule applies to, deontic refers to what is permitted, expected or forbidden (may, must, must not), the aim is the action to be achieved whereas conditions and sanctions describe the situation in which the act is to take place and the sanction that follow if the act is not seen through. Norms differ from formally sanctioned rules exactly in the absence of a sanctioning system. Vatn [18] notes however that the absence of a formal sanction mechanism does not mean that breaking norms goes without punishment. The internalization of norms, and the values inherited in them may cause a sense of guilt.

Summarizing the rich literature, we notice that institutions taking the form of norms and conventions (the non-legally sanctioned rules) govern the best part of everyday life. They are internalized and modified through interaction, friction and learning. (Some) water institutions take the legal form and they form the basis, the guidelines based on which end water users make decisions on how to abstract, use and manage water. These institutions are "translated" to everyday practices by local water users to better fit their everyday life and needs. It might be that the local manifestation of the legally-sanctioned institution (law) will different greatly than its original form. It might also be that local needs and particularities are not covered by the above mentioned institutions, thus enabling the creation of new, locally suited norms and conventions on how to best manage water.

For the purpose of this study we explore institutions, seen as social constructs that define choices in a going concern, let that going concern be a family, a community or a nation. The on-going transformative processes in Central Asia in general and Kyrgyzstan specifically, will most certainly bring a change in (water) institutions. The foreseen *institutional change* is understood as the creation of an institution in an area where no institution existed until that moment, or the replacement of an existing one. Theories of institutional change (*cf.* [19]) address the questions of how and why the institutional status quo changes. They approach these questions through different perspectives. Some theories start off from the assumption that change is spontaneous or designed, while others make the distinction between whether it is initiated by the "top" or the "bottom" of a hierarchy.

In this paper, the authors largely views institutions through Ostrom's disciplinary lenses to explore how "rules" are perceived by resource users and how this rules can offer a solution to CPR dilemmas. Resolving such a dilemma successfully might provide sufficient reason to initiate a bottom-up process of institutional change.

2.2. Social Dilemmas and CPRs

The social dilemmas paradigm has been widely studied by economists, biologists, psychologists, sociologists and political scientists alike. A social dilemma represents a situation of conflict between short-term self-interest, whereby individuals try to maximize their personal gains and long-term collective interest. According to Dawes and Messick [20] (p. 111) "[i]n social dilemma situations, each individual always receives a higher payoff for defecting than for cooperating, but all are better off if all cooperate than if all defect". The individual consequences of social dilemmas are often immediate or short-term, whereas the consequences for the collective are often delayed and first unfold over longer periods. Repeated social dilemmas represent a challenging situation for a society and thus embody significant obstacles for development [21,22].

Situations in which people have to collectively organize the provision or maintenance of CPR often represent a social dilemma. This type of dilemma is also referred to as "resource dilemma" or a "commons dilemma" and was first addressed by the ecologist Garrett Hardin in 1968, in the article "The Tragedy of the Commons". Hardin argues that the tragedy is inevitable whenever many people simultaneously use a scarce good [1,8]. Analyzing Hardin's metaphor, Ostrom [3] (p. 360) explains his logic of the inevitable tragedy by dividing the commons dilemma in two levels. The first level, *i.e.*, the first-order dilemma, focuses on the negative externalities that individuals impose on one another using a common resource. In other words, one user's extraction reduces the availability of the resource for others, while each individual derives a benefit using the resource, imposing a cost shared by all. Since all individuals, at least from a neo-classical economics point of view, are assumed to be selfish and profit-maximizing actors, each of them will try to increase her own benefit while only partially bearing the total costs. Consequently, this situation represents a "social trap" for users, leading to the overuse and destruction of the common resource. However, developing and enforcing institutions (understood as rules) that limit the access and/or the extensive use of the resource and hence prevent tragic outcomes might solve the first order dilemma. This solution though, creates a second-order dilemma concerning who will bear the cost of policing the rules once they are agreed upon. Due to the difficulty of excluding non-payers from consuming CPRs, a free-rider problem arises. Ostrom [3] (p. 360) summarizes that "it is not consistent with the conventional theory that individuals (*i.e.*, herders in Hardin's case) can solve a second-level dilemma when they are already predicted to be unable to solve the initial social dilemma". Therefore, Hardin and other scholars of the same opinion predict extensive free-riding and the incapability of users to self-organize and sustainably govern natural resources [3,8]. However, numerous case studies and field research indicates that optimal outcomes are possible.

2.3. Solving a CPR Dilemma

In order to solve the CPR dilemmas described above and thus achieve sustainable natural resource management, collective action is required. "Collective action occurs when a number of people work together to achieve some common objective" [23]. The common aim would be to prevent the overuse of the resources and thus preserve them in the long-run. However, it is argued by many scholars inspired by Hardin's article that individuals driven by their short-term, profit-maximizing self-interest are trapped in a vicious circle of resource overuse and cannot solve collective action problems without intervention. Therefore, external intervention, rule enforcement and clearly assigned property rights are required. The two consequential policy recommendations based upon the self-interest model are government regulation or privatization of the resources. In contrast, field research provides sufficient evidence that communities managing a CPR are able to avoid the tragic outcomes of the social dilemma and achieve collective action without external rules and enforcement imposed from the outside. Based upon a variety of field studies, Ostrom [8] showed that users can self-organize and are able to develop alternative institutions. These alternative self-crafted institutions can preserve the CPR in the long-run, often better than rigidly-defined public or private property rights. Furthermore, an increasing number of scholars contest the assumption of selfish-individuals, but offers instead a plurality of rationales influencing individual decisions especially when CPRs are concerned [2,8,18,24–26].

Self-governance appears as a response to CPR dilemmas and it is understood as a process whereby users of a CPR are involved in the process of crafting and modifying working rules (The term "working rule" is employed following Ostrom [27] (p. 19). We advocate that rules work, if they are accepted and generally applied by resource users at the local level. Many rules and regulations in Kyrgyzstan are currently ignored or not effectively implemented) that manage the resource over time [28] (p. 1317). However, this approach "was not mentioned in basic economic textbooks on environmental problems until recently", as explained by Ostrom [3] (p. 361) despite the fact that often self-organized communities that were concentrating on collective action rather than individual management of resources achieved better outcomes following simple principles [8]. These principles include clearly defined boundaries, rules that fit local conditions, collective-choice arrangements (*i.e.*, individuals who are affected by the rules are allowed to modify them), monitoring, graduated sanctions, conflict resolution venues and a minimal recognition of rights to organize (e.g., establish associations) [8] (p. 90).

While some of these factors describe group conditions for collective participation, others concentrate on the individual behavior of users, which are necessary for collective action solutions and rule compliance [29,30].

2.3.1. Group Characteristics Influencing Collective Action

Mancur Olson [31] was the first to conceptualize the theory of collective action. Although collective action is not always applicable in a CPR setting, user group characteristics enable or hinder collective efficiency. Such characteristics include group size, heterogeneity, communication and group composition [30] (p. 157), [27,31], [32] (p. 242).

Smaller groups are considered more successful when collective action is required as coordination within the group is easy, leading to lower transaction and monitoring costs. Moreover, the probability for conflicts is lower than in large groups. Finally, individual benefit from collective arrangements is perceived to be significantly higher in smaller groups [31].

Heterogeneity refers to the unequal characteristics of resource users. Participants in a group can be heterogeneous in many ways, such as their social position, economic status and accessibility to the resource. Group members can significantly differ in their social position and interest for the resource. [32] (p. 244) explains that "when users' interests for a CPR are of the same nature, users' 'social heterogeneity' lessens their capacity to make collectively efficient choices". Furthermore, the heterogeneity of exit options lowers the probability of efficient collective actions, offering instead economic alternatives to the CPR use. Finally, asymmetric access to the resource represents another heterogeneity aspect allowing some users beneficial access to the resource [32] (p. 244). Self-evidently more types of heterogeneity exist, such as cultural, ethnical, ideological, which although important for CPR management are deemed beyond the scope of the current paper.

Communication positively affects collective action by enabling the members of a group to identify common interests and plan a joint strategy to realize common objectives. Additionally, collective agreements can be established and individual tasks can be divided among users. Interactions allow group members to create a sense of solidarity and gain trust in one another, adding to their willingness to act collectively. Ultimately, communication offers the opportunity to influence individual user's strategy and correct it in case of non-social behavior. Ostrom [28] (p. 1321) explains that sanctioning in terms of verbal punishment (for instance the threat of social exclusion) effectively prevents users from defecting and thus restoring collective action [28,30].

Group composition refers to the proportions of different behavioral types of individuals within a group. Ostrom *et al.* [33] (p. 279) differentiate between four types of users: (i) free-riders, or those who will always behave in a selfish way and neglect cooperation; (ii) people who will only cooperate if they are certain that they will not be exploited by free-riders; (iii) individuals who are willing to initiate cooperation, hoping for the reciprocal behavior of other users; and (iv) altruists trying to achieve best outcomes for the entire group. The proportion of a certain type within a group will influence the likelihood of collective action. Most notably, the relative proportion of free-riders should be relatively small if collective action is sought [33].

2.3.2. Individual Compliance to Rules

While some studies focus on assumptions concerning how rule compliance can be achieved, others focus explicitly on the psychological explanation of individual compliant behavior. Individuals' subjective motives for complying with rules for CPR management are influenced by various factors to differing degrees. These factors can be based upon economic, psychological and sociological reasons, providing the corresponding analytical models [34].

From an economic perspective, compliant behavior (cooperative strategy) is primarily based upon the benefits and costs (*i.e.*, the payoff structure) resulting from such conduct. In order to prevent free-riding, the important tool of sanctioning cost is introduced [32]. The effectiveness of this instrument depends on two interrelated variables, namely (i) the perceived probability of being caught while breaking the rule and (ii) the harshness of the expected sanctions. Following the assumption that individuals make rational choices, obedient behavior can be increased by incrementing the level of monitoring, the severity of punishment, or both. However, increasing the level of monitoring is not always possible due to technical and/or pecuniary reasons; moreover, individuals still find techniques to avoid detection and avert regulations [28,34]. As explained by Jenny *et al.* [34] (p. 240), while the economic model neglects individual and social factors, psychological and sociological models highlight their importance, including variables such as individual moral, social norms and the legitimacy of rules in their theories.

Individual moral refers to the strong personal feeling of commitment to follow rules and thus "to do the right thing" despite the possibility of higher gains and free-riding. In such a case, it is in the individual's nature to follow a general norm and obey rules. Social norms, the second variable, can be understood as group-held beliefs about what is adequate in a certain context. These beliefs constrain personal actions because either individuals share them or they fear being punished by others in case of unsocial or non-appropriate behavior. Nonetheless, there are certain social dynamics involved; when everybody within a community disobeys, rule breaking becomes an acceptable norm as individuals adapt their actions to the behavior of their community [32,34]. Ostrom [30] (p. 161) adds that norms are learned and thus vary across persons, situations and time periods within any specific context. Finally, legitimacy of rules describes distributive, procedural and interactional fairness in organizational situations [34] (p. 240).

Distributional justice analyses the effects of rules on fair distribution of a resource. Hence, resources can be distributed proportionally to the initial amount of contribution (equity rules), while on the other hand they can be divided equally among the users (equality rules); finally, the distribution can occur based upon the individual needs of users. Given the variety of distributive rules, an individual will choose the one that he or she prefers most. This personal preference will depend upon individual, circumstantial and cultural aspects, reflecting the desirable distribution. Procedural justice deals with fairness during the process of crafting and applying the rules, including desirable features such as democracy, transparency and participation. Additionally, interactional justice depicts elements of interpersonal fairness (e.g., respect, politeness *etc.*) and describes their depths during the rule development process. Jenny *et al.* [34] (p. 242) conclude that "[r]ule compliance has been found to occur more often when rules are legitimate in the sense of these forms of justice" [24,34].

Although an individual perspective is very important when analyzing rule compliance, circumstantial factors cannot be neglected. Rules should fit local conditions and thus be perceived as acceptable [8]. Preceding behavioral routines can hinder or foster the effectiveness of a newly implemented rule. Consequently, compliance with new rules must become a day-to-day habit adopted in the behavioral routine. Moreover, external factors like access to new markets or an increase in resource prices may lead to increased non-compliance of protective rules based upon the monetary incentives to not obey augment [8,34].

Summarizing the numerous studies we can safely argue that as a minimum the success of CPR management strongly depends on cooperation and the level of rule conformance in the community. This level is determined by numerous variables, including social norms, legitimacy of rules, participation and the consideration of local context (see Table 2) and can be increased via monitoring, sanctions and/or communication [8,34].

Table 2. Determinants of individual compliance behavior.

Factor	***Variable(s)***
Economic factor	Payoff structure
Personal factors	Personal morals, general norm orientation
Social norms	Social norm
Legitimacy	Distributive, procedural, interactional fairness
Contextual factors	Compatibility, adequacy, habits and behavioral routines, external factors

Source: own illustration based on Jenny *et al.* [34].

3. Methods

In order to explore the role of cooperation and of rule conformance within a community in terms of sustainable CPR management, we conducted a field experiment, a post-experimental survey, group discussions and semi-structured interviews with irrigation water users. The following section, after introducing the case study area, will describe each of the methods.

3.1. The Case

Kyrgyzstan gained full independence from the Soviet Union in 1991. Since then, and despite some recent reforms, the country struggles to achieve sustainable management of its natural resources.

After briefly explaining the historical background of the country's experience with water management, this chapter will explain the current water governance arrangements and its problematic issues. Subsequently, to demonstrate Ostrom's theory of self-governance in practice, a field study conducted in Kyrgyzstan in May 2014 will be presented. However, the main emphasis of the research was placed upon the analysis of individual behavior of irrigation users under different rule settings, rather than the management success or failures of the analyzed communities. Irrigation systems are important CPRs in Kyrgyzstan, where the economy is primary agricultural and the majority of its population (65%) lives in rural areas [35]. According to UNECE [36] (p. 11), 90% of the total water consumption in the Central Asian country is used for agricultural irrigation; moreover, "[t]he irrigation infrastructure comprises 1030 irrigation and collection-drainage systems", whereby 31.6% is managed by public authorities. Local administrations, federations and water users' associations own the remaining 68.4% of the systems.

Traditionally, irrigation systems were managed by local water masters ("mirabs"), which were responsible for water distribution and maintenance of the canals. A community of water users elected the "mirab", paying him/her according to his/her performance. Furthermore, community elders ("aksakals") supervised the overall organization and process of irrigation. Finally, all members of the community maintained the irrigation systems during the annual collective obligatory work called "ashar". However, when irrigation management was "administratively centralized" during the Soviet regime (1918–1991), these traditional arrangements were officially eliminated, only informally remaining present [37] (p. 19).

After the collapse of the Soviet Union in 1991 and the disappearance of the financial, technical and managerial support for the irrigation sector from the former Soviet government, the Kyrgyz government was incapable of efficiently maintaining and operating the irrigation infrastructure [37]. According to UNECE [36] (p. 12), the subsidies towards the irrigation sector declined up to five times (compared to the level of the early-1990s), leading to serious investment deficits and hence a deterioration of the sector's conditions. A deteriorated infrastructure, lack of financial means and experts, as well as the challenge to reform an inadequate hierarchical (post-soviet) water governance system, led Kyrgyzstan to find itself in urgent need of financial and operational support, which was subsequently provided by international donors like the World Bank [38]. However, this support was given under the condition of implementation of new reforms and thus the reduction of the financial burden of irrigation governance on the national budget. McGee [37] (p. 25) states that consequently a broad reform of the irrigation system was introduced in 1999, including the "[…] complete devolution and transfer of management, maintenance, and irrigation investment tasks from government institutions to private community-based farmers' organizations known as Water Users' Associations (WUAs)". Although the formation of WUAs is considered a major progress, the country is still struggling with an unsatisfactory water infrastructure and unsustainable water use according to most experts [36]. According to McGee [37] and Sehring [39], many WUAs are failing to overcome CPR dilemmas that are integral in irrigation systems and problems, such as the non-payment of irrigation service fees and/or violations of distribution rules that hinder the achievement of collective action. These problems and the incapability to prevent the selfish behavior of some farmers have a particularly negative impact on downstream-located farmers, worsening conflicts over water in many regions [37]. Sehring [39] (p. 277) adds that "[…] the local governance does not provide the necessary incentives and conditions for the reform to become effective"; consequently, the newly-implemented formal rules are not perceived as legitimate and are weakened by informal ones. This is considered the main cause of the problems mentioned above.

The authors explored these claims in two Kyrgyz communities called Tosh-Bulak and Saz, which are near the capital Bishkek (Chuy Province) in the Sokuluk river basin (see Figure 1). The communities were chosen for the study due to the regular use of irrigation channels to water land plots. 20 farmers from the two communities volunteered to participate in the research. Consequently, they were divided into four groups of five participants. All participants were small farmers who are mainly dependent on agriculture, producing fruits, vegetables and grain for self-deficiency as well as profit generation.

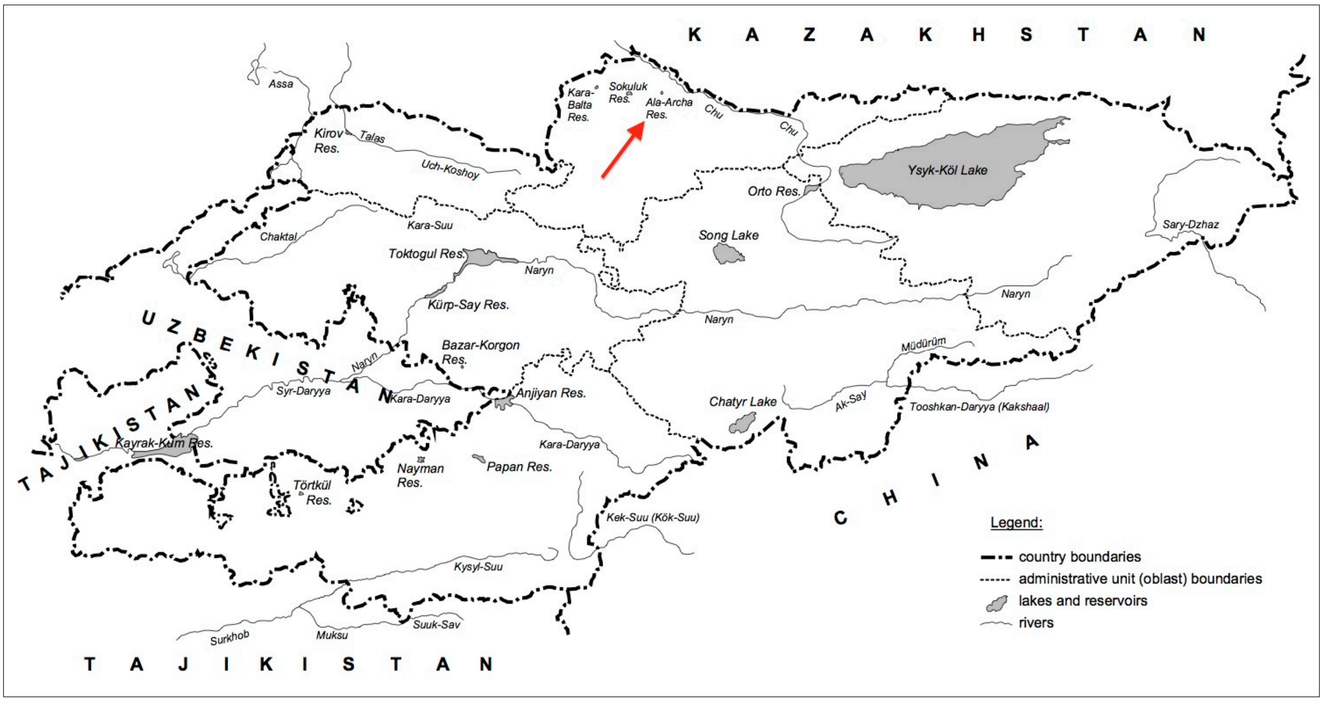

Figure 1. Map of Kyrgyzstan and study location. Source: UNECE [40] (p. 70).

Similar to our experiment discussed in the following sub-section, users were located along an irrigation channel with upstream and downstream access to water within the community. Each experiment took approximately two hours and was conducted in Russian and Kyrgyz languages. Subsequently, questionnaires were filled, group discussions took place and personal interviews were conducted. In terms of age, 50% of the players were below 40 years, 40% were between 40–60 years and 10% were over 60 years old. The majority of participants were men (65%).

3.2. The Irrigation Game

The water irrigation game was designed by Cardenas *et al.* [41] with the novelty of incorporating the specific ecologic characteristic of the CPR, *i.e.*, a vertical downstream flow, into the experimental design. It allows the analysis of the collective action problems especially in terms of provision and extraction. Therefore, the game structure simulates a social dilemma where individual goals (e.g., maximizing the profit) diverge from optimal outcomes for the community as a whole, whereby all players contribute to the CPR. Hence, the experiment explores the effects of specific resource dynamics on the social dilemma situations. Based upon the knowledge acquired on such effects, better rules for

CPR management can be developed [41]. The experimental design was later adapted by Zikos *et al.* [42], including the possibilities of sanctioning, communication and rule-crafting of the participants to analyze the impacts of externally enforced and self-designed allocation rules on the behaviors of resource users. The adapted version of the irrigation game was employed by the authors as it represents a suitable tool to analyze the individual behavior and rule compliance of the experimental subjects who jointly use an irrigation channel under "formal" (externally imposed and monitored) and "informal" (self-crafted allowing greater flexibility of monitoring, enforcement and sanctioning) rules.

The experimental design has been extensively described in other papers (*cf.* [42–44]) and thus we refrain from repeating the details of the game. However, it is important to offer a brief account of the game so as to enable the reader understanding our method.

The irrigation game is designed for a group of five players (A–E) and comprises three different stages with ten rounds in each, *i.e.*, 30 rounds overall. The participants act as users of an irrigation channel, whereby each player has different access possibilities to an asymmetric CPR, *i.e.*, player A is located upstream, then comes player B and so on. The last player (E) has the most downstream position (see Figure 2).

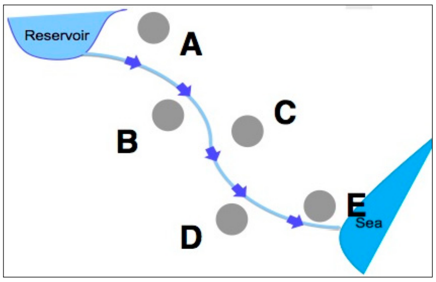

Figure 2. The location of the players along the irrigation channel. Source: Otto and Wechsung [43].

In every round throughout the game, each player is confronted with two decisions: (i) how much to invest in a common irrigation system and (ii) how much water to harvest. Both decisions are made confidentially.

The earnings for each player depend on how many tokens she saved from *not* investing during her first decision, plus the amount of water harvested during her second decision. However, the total investment of the players (sum of their first decision) generates a certain amount of water (see Table 3), which can subsequently be harvested from the common pool by the players (second decision).

Table 3. The relation between total group investment and available water for harvesting.

Total Group Investment for Channel Maintenance	Available Water in the Irrigation Channel
0–10	0
11–15	5
16–20	20
21–25	40
26–30	60
31–35	75
36–40	85
41–45	95
46–50	100

Source: own illustration based upon Cardenas *et al.* [41].

The relationship between total investment and water availability in the channel generates (i) an interdependent relation among group members, as well as (ii) the free-rider problem. Accordingly, upstream participants depend on the downstream players to generate a favorable amount of investments. On the other hand, players located further downstream can only extract water if upstream players do not entirely deplete the resource. Secondly, players can choose to behave selfishly and not contribute to the common pool, hoping to enjoy the benefits freely based upon the investments of other players, *i.e.*, to free-ride. However, if this becomes a dominant strategy for each player, no investments will be made and thus no water will be provided. This exposes the provision problem of CPRs. On the other hand, social optimum can be achieved when everybody chooses to cooperate [41,44].

In the first stage (10 rounds), resource users are playing without any extraction rules and without communication, while in the second stage we introduce the treatment of "externally imposed rules". Finally, during the third stage of the game, the players are introduced with a different treatment whereas they can communicate, design and apply their own rules. The original experiment by Cardenas *et al.* [41] has two stages where players are not allowed to communicate, but in our research we added the third stage of communication in order to investigate the effects of self-crafted rules (version also employed by Otto and Wechsung [43]).

The first stage of the experiment allows observing whether or not self-governance exists and how asymmetric location influences the decisions and revenues of irrigation users. In the second stage three different extraction rules are presented, for which every player can vote anonymously to be implemented during the ten subsequent rounds. The rule with the most votes will consequently be implemented during this stage. The available rules are: (1) random water distribution; (2) rotation and (3) property rights. All three rules regulate harvesting and are directed at solving the CPR dilemma, nevertheless cheating is possible, including a risk of being caught and sanctioned (1/6 probability). The aim of the second stage is to examine the influence of externally enforced rules on resource users' behaviors and revenue [41–43]. During the last ten rounds of the game, participants are allowed to communicate every other round and discuss strategies, distribution rules, monitoring and sanctioning mechanisms. However, individual decisions of investment and harvesting are made confidentially. Therefore, the last stage allows investigating the effects of self-designed rules [42,43].

Generally, the structure of the experiment allows comparing the second and third stages, focusing on the compliance levels for formal-exogenous and self-designed (often completely informal) rules. This comparison is hence central in answering our research question. It must be stressed that although the employed experiment offers much space for an in-depth econometric analysis, the authors opted for a more qualitative analytical approach targeting a wider audience of researchers from different disciplines.

3.3. Additional Methods

As an additional tool to understand and explain players' decision in the experiment, a post experimental survey was conducted. Immediately after the game, each participant was asked to complete a questionnaire comprising 21 closed questions regarding the game, the actual irrigation practices in the communities and the reasoning for personal decisions during different stages of the game. Thereby, players could choose one or several best options from the range of responses and/or provide a personal statement. The purpose of using questionnaires was first to collect factual data (size of agricultural production, income, gender, age) about each player and, furthermore, to gather qualitative information about the individual decision-making process under the different treatments, as well as analyzing the effects of communication.

As a further analytical tool, the group discussions within and between different groups were used to collect general impressions about the experiment, recommendations for improvement and to allow the authors conducting both participant and direct observation. Furthermore, these discussions are helpful to stimulate reflective thinking among the members and reveal real-life issues in the communities regarding the use of the CPR and related collective action problems. Finally, this background information is helpful in analyzing both individual and group behavior.

Last but not least, the researchers selected 8 individual players (four intuitively based on observed behavior, four randomly) for a personal semi-structured interview. Input from the interviews provided insights but also vital information for explaining the reasons and motivations for certain decisions of the participants, as discussed in the next section.

4. Results and Discussion

4.1. Descriptive Results

In this section, the groups' outcomes in the total game and three different stages will be presented and discussed. Similar to the results of Cardenas *et al.* [41], entirely selfish behaviors of irrigation users are not observed in any of the four groups. On average, players invested 56% of their budget to develop and maintain the CPR, *i.e.*, the irrigation channel.

Although no group in the experiment reached a social optimum, the results achieved remain high for some groups. Figure 3 summarizes the results of the overall performance of each group, including total investment, harvesting and revenue.

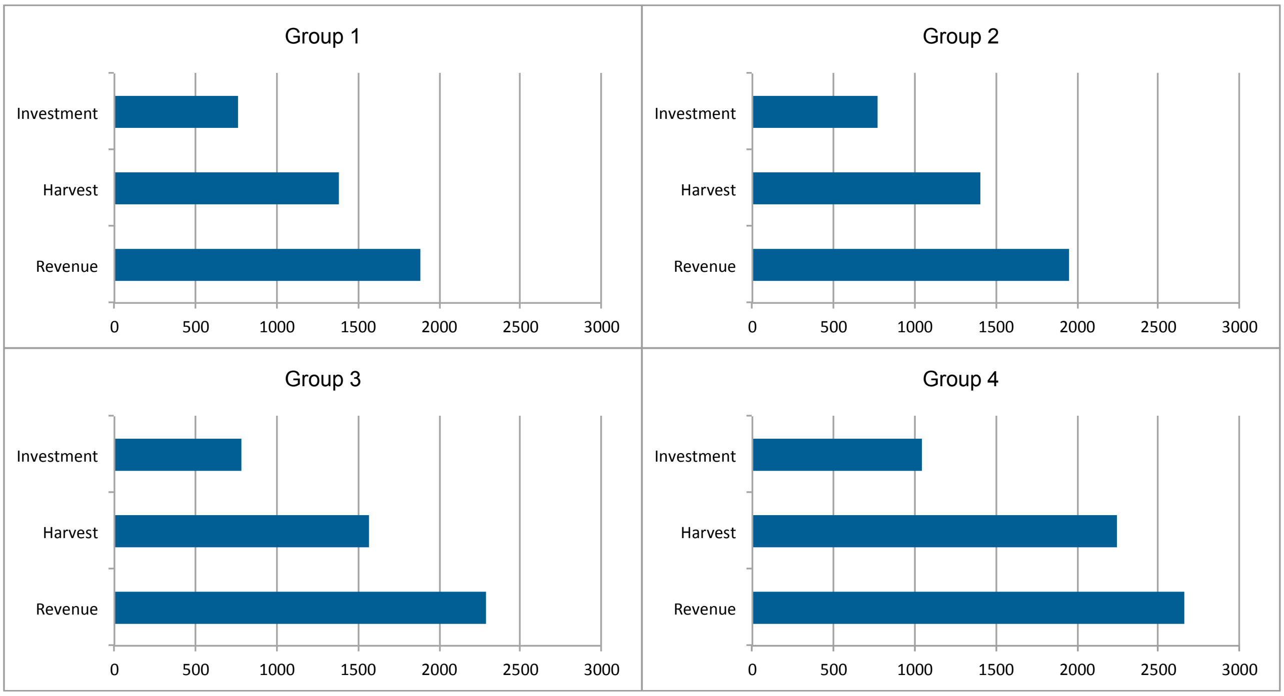

Figure 3. Total Investment, Harvest, Revenue per Group (in tokens/water units). (Source: own illustration based upon data collected during the field study.)

Furthermore, it shows the amounts of illegally extracted water in each group. Group 4 (G4) managed to achieve the highest investment number of 1047 tokens, followed by Group 3 (G3), Group 2 (G2) and Group 1 (G1), with 787, 770 and 764 tokens, respectively. Consequently, the groups' order for the harvested amounts and total revenues remained the same. Analyzing the average numbers, a player invested 5.61 tokens and harvested 11 water units, thus earning a total sum of 14.64 tokens per round. So far, only the overall results of the experiment have been presented. However, it is very interesting to analyze the different stages of the game separately to observe the influence of no rules (stage 1), exogenous rules (stage 2), as well as self-crafted rules and communication (stage 3) on the groups' performance.

The overall performance of the groups in different stages can be observed in Figure 4. After playing the first ten rounds without restrictions on appropriation levels, three rules regulating the water extraction were introduced in stage 2. In general, 70% of all players voted for the second rule (rotation order), 25% for the third rule (equal distribution), while only 5% chose the first rule (random withdrawal). Later, in stage 3, in which communication and self-design of rules were allowed, a variety of modified or new rules were implemented. Interestingly, three of the four groups (G1, G3, G4) show the same performance pattern across the stages. Accordingly, investment, harvest and revenue amounts decreased in all of these groups under externally imposed rules, while users achieved the highest levels of the same variables under self-crafted rules. In contrast, G2 performed best during stage 1, while the worst performance occurred under self-organization in stage 3.

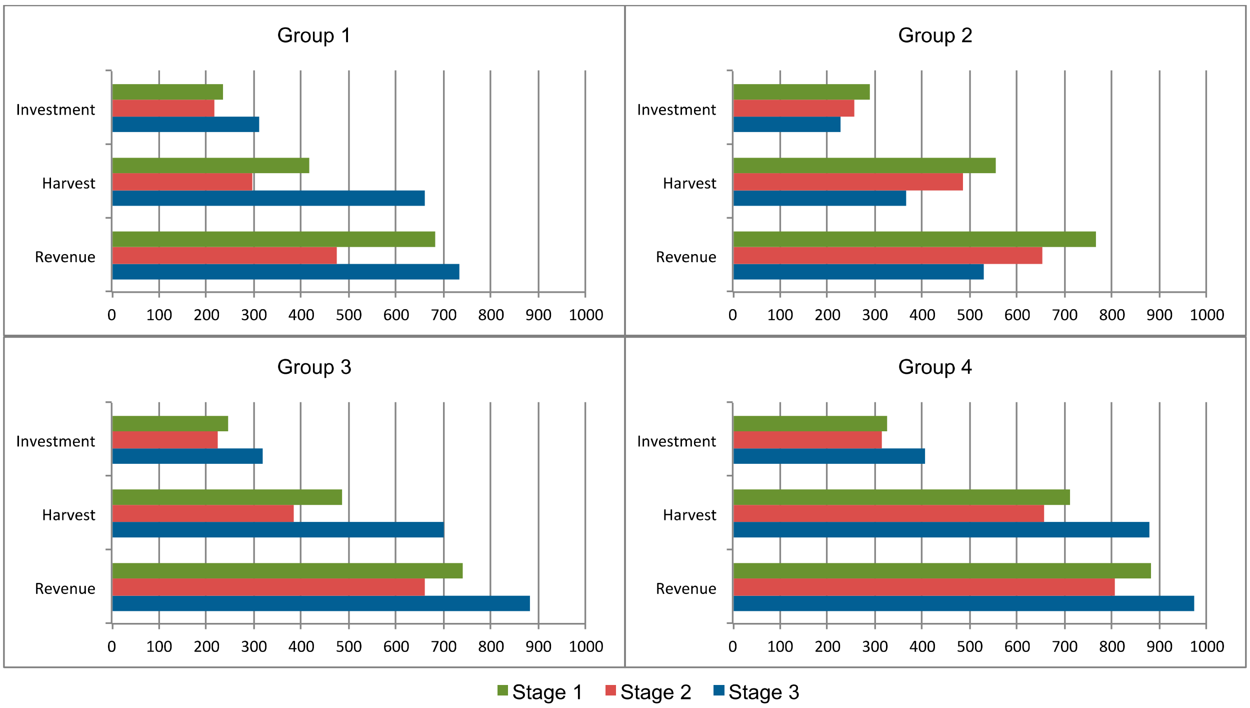

Figure 4. Total Investment, Harvest and Revenue per Group (in tokens/water units) in all stages. (Source: own illustration based upon data collected during the field study.)

Finally, in order to have the "whole picture", it is interesting to observe how the revenues of the study groups were distributed among the players in the different stages, as detailed in Figure 5. Remarkably, the group with the worst overall performance (G1) presents the most equal distribution of water during stage 2, whereas the best performers' (G4) distribution structure was dominated by one player, collecting up to 58% of available water in stages 1 and 2.

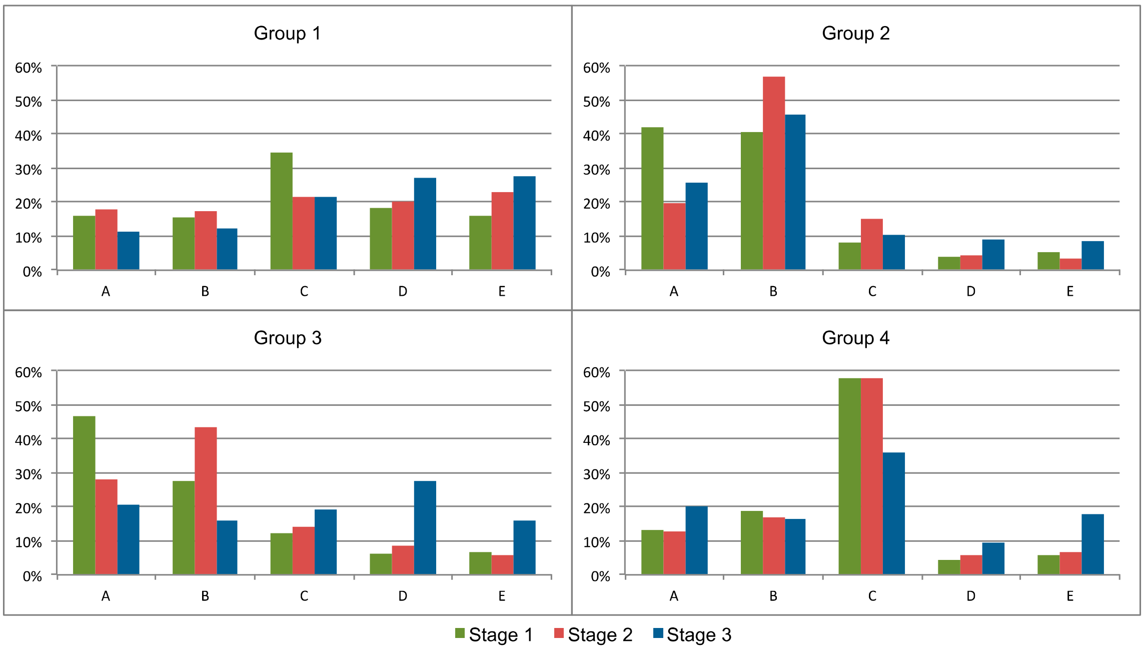

Figure 5. Water distribution among the players in stages 1, 2 and 3. (Source: own illustration based upon data collected during the field study.)

4.2. Rule Violations and Illegally Extracted Water

In order to answer the main research question of this paper, this section examines the compliance levels for exogenous and self-crafted rules. Therefore, two quantitative variables will be studied in detail, namely the number of rule violations and the amount of illegally extracted water. The analytical strategy is firstly to compare the development of both variables in stages 2 and 3 (Figure 5) and secondly to explain the results with help from the information collected via the questionnaires, as well as the group discussions and face-to-face interviews. Moreover, the focus will be placed upon group and individual variables, previously defined in chapter two of this paper, which influence cooperation and thus rule compliance.

Figure 6 shows that three groups (G2, G3, G4) managed to reduce the amount of illegally extracted water under self-designed rules, whereas in G1 this number was higher. Furthermore, one can observe that incidents of cheating declined in stage 3 in G1, G3, G4, while the number of violations remained unchanged in G2. According to this analysis, one can state that users generally showed higher compliance to their self-crafted rules than the externally imposed rules, reducing the total amount of illegally extracted water in stage 3 by approximately 30%. Let us now analyze the reasons for this development by firstly looking at the groups and subsequently the individual behavior of some players.

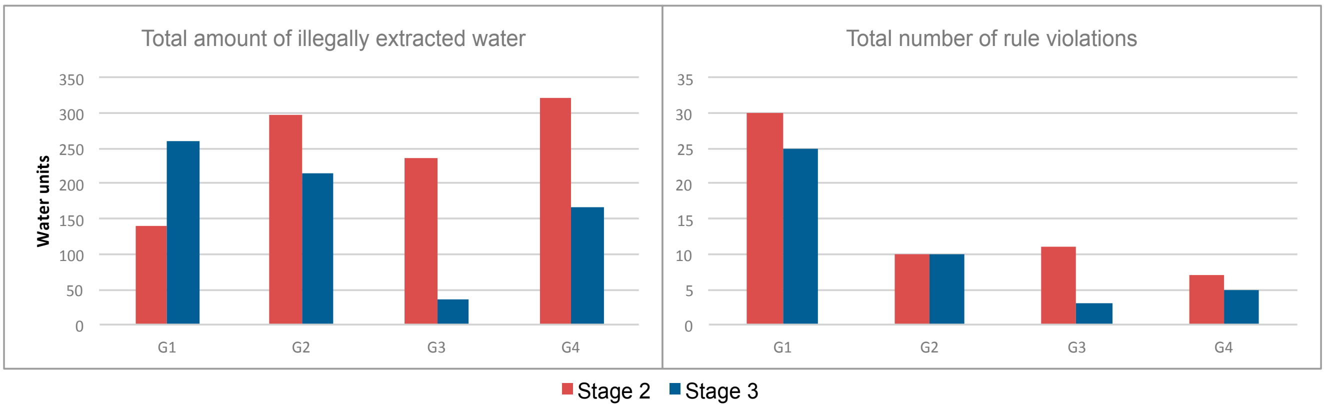

Figure 6. Illegally extracted water and number of rule violations per Group in stages 2 and 3. (Source: own illustration based upon data collected during the field study.)

The results mentioned above can be explained by firstly analyzing group characteristics such as group size, heterogeneity, communication and group composition, which influence the effectiveness of collective action. It is stated that small homogenous groups with a relatively minor share of free-riders are more successful in achieving collective action and restraining personal overuse of a resource. Furthermore, communication among the group members allows developing an efficient strategy for CPR management, as well as influencing and thus correcting individual users' unsocial behavior [30–32]. In the current field study, all four groups comprised five participants and can hence be considered as small. Furthermore, in stage 3, each group had the possibility to communicate. Moreover, the members received the same budget for investments in each round and were assumed to have the same land plots to irrigate. Additionally, no one in the group had an alternative to generating revenue other than the usage of CPR. Therefore, the economic situations and the interests for the resource were homogeneous. However, participants in each group had different access possibilities to the resource with players A and B being positioned upstream, player C in the middle, while player D and E were placed downstream along the irrigation channel. This represents heterogeneous positions and access possibilities for different players within each group. Finally, in order to analyze which type of users composed each group, the individual behavior of users in each group was analyzed. As previously mentioned, Ostrom *et al.* [33] (p. 279) differentiate between four types of users: (i) free-riders; (ii) reciprocal co-operators; (iii) individuals who initiate cooperation and (iv) altruists. Thus, to achieve collective action, the relative proportion of free-riders within the group should be relatively small.

We observed that in G1, every player exhibited an occasional rule-breaking behavior. In G2 and G4, however, only one player in each group was responsible for the vast majority of illegal water harvests. In G3 some players broke systematically the rules in stage two, while almost no water was collected illegally in stage three. In conclusion, everybody in G1 was occasionally free-riding, while in G3 the majority comprised co-operators with some exemptions. In G2 and G4 however, one player was always free-riding. This observation confirms Ostrom *et al.* [33], arguing that a small share of free-riders can still allow successful collective action. As demonstrated earlier, G2, G3 and G4 despite free-riding incidents significantly reduce the amount of illegally extracted water under self-designed rules (stage three), whereas in G1 this number increased.

Having discussed the group variables that influence collective action, we will examine individual patterns of behavior and especially how these changed in stage 3, under self-crafted rules. Compliance to the rules is presented in Figure 7.

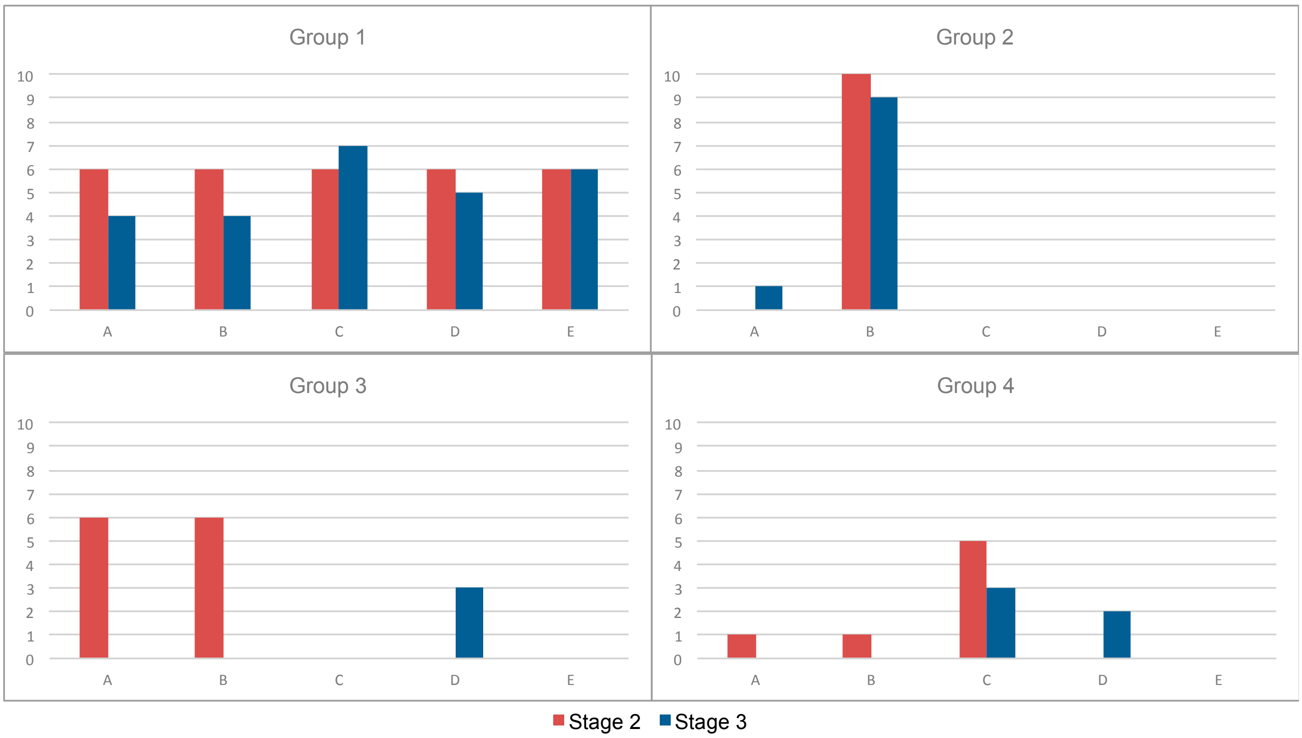

Figure 7. Number of rule violations per player in stages 2 and 3. (Source: own illustration based upon data collected during the field study.)

In stage 3, players of G1 and G4 did not modify already set rules (1, 2, 3) but were trying out two or all of them during different rounds of stage 3. Surprisingly, although G3 implemented the same rule as in stage 2, during the entire ten rounds the amount of illegally extracted water was reduced by 85%! Finally, G2 was the only group to opt for increasing the level of monitoring. In the following we analyze individual players' behavior.

Player B2: According to Faysse [32], Jenny *et al.* [34] and Ostrom [28], incrementing the level of monitoring can reduce free-riding by influencing the personal payoff structure. However, in the case of player B in G2, it was not very efficient: in general, he invested less in the CPR than other players and was extracting all water from the common pool in every round (despite sanctions). Given his upstream position, no water was left for other players allocated after him. When asked during the interview why he did this, he firstly replied, "I didn't understand the game". However, when the question was formulated again, the player responded, "actually it is the same way with us (*i.e.*, in our village), some [farmers] also take all the water and do not leave anything to others until we go and tell them to open the channel again". Hereby, the player was referring to the actual selfish behavior of some farmers in the community, although he did not directly admit that he was behaving in the same way during the game.

Player C4 had a similar strategy to player B2, investing less than other players and collecting water illegally in both stages. However, he changed his strategy after the third round of the stage, complying with the rules implemented during the remaining rounds. Thus, the total amount extracted during the last stage was reduced by almost half compared to stage 2. Analyzing the questionnaire and the interview answers, no reasons were found for the initially chosen strategy or its change. Nevertheless, it seems that communication had a considerable impact influencing the individual moral of the player by “correcting” his unsocial conduct. As described by Ostrom [28], sanctions can also be imposed in terms of verbal punishment, which occurred in G4. As soon as players were allowed to communicate, they urged player C to behave correctly and leave some water for players located after him/her. Furthermore, it was observed that player C’s investments in the CPR increased during stage 3. As marked in the questionnaire by the player himself/herself, this decision was influenced through communication. Hence, group discussion and communication seemed to restore collective action within the group, whereby player C’s personal feeling of commitment was increased.

Players A1-D1: Group 1 presents an interesting case, given that all players were extracting water illegally in stages 2 and 3. Here, two possible reasons exist. Firstly, a possible explanation can be found in the studies conducted by Faysse [32] and Jenny *et al.* [34], where the authors explain that individuals adapt their actions to the behavior of their community. In the case of G1, “rule-breaking” seems to have become a social norm, which was subsequently adapted by each individual in the group during both stages. However, when analyzing the data exactly, the second explanation seems to be more appropriate here, given that players often state that they did not quite understand how rules 2 and 3 function. In other words, after observing the data, it can be seen that although rule 2 was selected in the second and rules 2 and 3 in the third stage, the participants always played according to the second rule. The group even achieved the most equal water distribution in stage 2 of the game. Compliance to rules other than the chosen one also explains the worst overall performance, because G1 had paid the highest amount of sanctions of 225 tokens.

Players A3 and B3 also seem to have been influenced through communication, since the chosen rule remained unchanged during stage 3, as well as other factors.

Other players generally complied with rules irrelevant to their source (exogenous or decided and crafted within the group). According to the discussions and interviews these players considered the implemented rules as being apt to local conditions, legitimate and fair in their distributional, procedural and interactional mechanisms. Furthermore, rules even during stage 2, were chosen democratically, thus presenting procedural justice. Finally, it should be highlighted that the participants treated each other with respect during discussion rounds in stage three, so the interactions resulting to the introduction of new rules in stage three were also fair. To conclude, these results confirm findings made by Agrawal [24] and Jenny *et al.* [34] concerning how rules are rather followed if they are legitimate in terms of distributional, procedural and interactional fairness.

4.3. Lessons Learned from the Field Experiment: Working Rules in Irrigation Water Management at the Community Level

The field experiment allowed us to gain some first insights from the communities under study and formulate certain hypotheses that were further explored with the complementary methods described in Section 3 of the paper. During this stage of the research, the authors extracted information from interviews and focus groups on the actual working rules in the study area and coupled them to the experimental results as shown in Table 4.

Table 4. Relating the working rules in the irrigation water management and experiments.

Lessons on the Working Rules	Interview Excerpts	Experimental Results
Game reflects well the working rules in the irrigation water management at the community level *Rotational water distribution is applied in the communities*	"We use a rotation system, where the user takes some amount of water out, leaving the rest of water for the people after him/her" (Saz).	70% of players selected the rotation rule.
Asymmetry in the access to irrigation water resources *No big issues within the community* *The main problem is related to water scarcity in the downstream villages*	"Yes, we have sometimes problems with the downstream village. However, we still take as much water as we want" (Saz).	High tolerance towards free riding of the upstream water users. Low reciprocity.
Relation between investment to public infrastructure and water distribution *Contribution to the public infrastructure does not guarantee access to water*	"I hoped that the person upstream would have enough water and leave some for me." (Tosh-Bulak).	Despite the free riding problem all players invested 56% of their budget to develop and maintain the CPR.
Monitoring and sanctioning *Monitoring by "mirab", but no effective sanctioning mechanism at the community level*	"We have a control through 'mirab', but no a sanctioning mechanism…" (Tosh-Bulak).	Investment, harvest and revenue amounts decreased in all of the groups under externally imposed rules (stage 2 of the game).
Formal rule breaking	"…there are I would say more than 20% of the people don't pay, but what will you do?	We observed that everybody in G1 was occasionally free-riding, while in G3 the majority comprised co-operators with some exemptions. In G2 and G4 however, one player was always free-riding.
20% of water users do not contribute to the public infrastructure (payment for water service)	"There is a penalty for those who take water out illegally (around 500 som), but…" (Saz). "…everybody (some more, some less) receive water, also those who don't pay" (Tosh-Bulak).	
Learning process *People learn in their daily interactions about the value of cooperation*	"At the beginning it was more difficult, but now it is easier." (Assistant of the water master "mirab" in Tosh-Bulak).	Cooperation has been improved considerable in the third stage. Players were allowed to communicate and design own rules, having also learned from the previous stages.

Keeping our account short as a broader discussion would be beyond the scope of the current paper, in the following we elaborate further on the lessons learned from this coupling process. Thus, we aim at paving the way for further research.

4.3.1. Experimental Setting and Real-life Situations

We argue that at least in the particular area of the study, the experimental results reflect the actual working rules in irrigation water management at the community level. The participants of the focus group confirm: "The game is a game, but it is 100% like that in real life as well" (focus group discussion in Tosh-Bulak). Indeed, 70% of all players voted for the second rule (rotation order), which represents the actual working rule in the communities: "We use the rotation rule, while everybody takes some amount of water out, leaving the rest of water for the people after him/her" (interviewee Saz).

4.3.2. Unmonitored Water Abstraction and Free-riding Tolerance: Asymmetry and Investment

Both Tosh-Bulak and Saz communities are located in the upstream part of the Sokuluk River basin. Thus, the villagers have relatively low asymmetry in the access to irrigation water within the community. This could explain the reasons behind the tolerance towards the free-riding in water use by the upstream players in the experiment. Each player invested an average of 56% of the available budget to develop and maintain the irrigation channel. A downstream player explain his decisions: "I only hoped that the person upstream would have enough water at some point and leave some water for me. It is like in our village. We pay 100 Som, but we don't have any guarantee that the water always reaches us" (interviewee Tosh-Bulak).

It seems that according to the working rules in the communities, the contribution to the public infrastructure does not ensure access to irrigation water. However, this is widely accepted in both communities as the villagers enjoy relatively good access to irrigation water from the Sokuluk River and thus tolerate incidents of free-riding while detailed monitoring of the abstracted volume of water is not an issue.

The water users in Saz support this observation: "Yes, we have sometimes problems with the village located more downstream of the river (because they only get the water amount that we leave). However, we still take as much water as we want" (interviewee Saz).

4.3.3. Rule Breaking as a Working Rule

An interesting observation is that everybody in G1 was occasionally free-riding, while in G3 the majority comprised co-operators with only few exemptions. In G2 and G4 however, one player was systematically free-riding. This mirrors the actual situation in the irrigation water management in the communities: About 20% of water users break the formal rule and do not pay water fees (according to the communal statistics). There is some monitoring of water use by the water master at the community, but sanctioning mechanisms are absent. During the focus group discussion, water users in Tosh-Bulak inform that: "[…] everybody (some more, some less) receive the water, also those who don't pay […] we have a control through 'mirab', but no sanctioning mechanism, we all know each other. We cannot go and charge a fine to somebody we know! Only in some serious cases, we may go to the local court" (focus group discussion in Tosh-Bulak).

4.3.4. Learning Effects

Finally, the study results demonstrate that water resource users learn the effects of cooperation in water management in the game, in a similar way to the learning processes involved in their daily interactions. The assistant of the water master in Tosh-Bulak recalls: "at the beginning it was more difficult, but now it is easier. People started to understand how the system works and cooperate more […]" (interview with the Water Master Assistant in Tosh-Bulak).

This situation has been reflected in the experimental findings and the decisions of the players. Cooperation has been considerable improved in the third stage of the game when the treatment of communication and rule-crafting was introduced. However, as several of the interviewees stated, the learning effects have greatly enhanced cooperative behavior.

5. Conclusions

The aim of this paper was to firstly introduce CPRs and present issues related to their sustainable management and then to examine in an exploratory way the potential of self-governance arrangements as a solution. A field study was carried out to analyze the efficiency of self-management practices and identify conditions for their success.

Findings of the research support numerous field studies suggesting that various communities achieving sustainable outcomes have relied on flexible institutional arrangements such as self-governance. This further indicates that neither government intervention nor market incentives can provide a blanket solution and hence guarantee preserving valuable resources from overuse and depletion in the long-run. Communities have managed to design and enforce suitable institutions for collective action to achieve socially optimal outcomes when managing a common pool resource. Although self-governance can take diverse forms in different communities (including various rules regulating the use and distribution of a CPR), the crucial factor for the success of this approach is the individual compliance of community members to the self-crafted and enforced rules. Therefore, the leading research question studied in this paper was whether resource users will present a higher level of compliance for the self-designed rather than the exogenously designed and imposed rules.

To answer this question, the authors identified and analyzed users' behavior in two Kyrgyz communities. Kyrgyzstan represents an interesting case as it is struggling for years and with different approaches to achieve sustainable use of water with limited success despite recent reforms and attempts to realize a transition from central to community-based water management (*i.e.*, implementation of WUAs). The field research undertaken followed a mixed method approach (including a field experiment, questionnaires, group discussions and face-to-face interviews) focusing on the factors that influence collective action. These factors comprised group characteristics such as group size, heterogeneity, communication and group composition, as well as individual variables like social norms, legitimacy of rules, participation and the impact of external factors, among others.

The findings of the research indicate that selfish behavior of irrigation users is rather limited. Furthermore, three of the four analyzed groups performed best under self-enforced rules, achieving the highest levels of investment, harvest and revenue. In the same groups, self-designed rules positively influenced the distribution of the CPR among upstream and downstream players. The analysis of these findings suggests that group and individuals' characteristics influenced participant's cooperative behavior as the total amount of illegally extracted waster was reduced, increasing also the compliance of the subjects. Regarding the group variables, it was observed that within a small, relatively homogeneous group with a relatively small share of free-riders, irrigation users were able to communicate and enforce rules that foster collective action. Considering individual behavioral patterns, it can be confirmed that communication strongly influenced the cooperative behavior of game participants, leading to fewer rule violations. Furthermore, decisions to cooperate were positively influenced by individual morals, social norms and the legitimacy of rules. It should be noted thought, that few individuals followed a selfish, profit-maximizing strategy throughout the whole game, and were barely influenced by sanctions, communication and/or social norms.

Despite collecting useful data and gaining valuable insights into users' motivations to comply with rules, some limitations of the study have to be recognized. Similarly to the observations made by Zikos *et al.* [42], some difficulties emerged while applying the methodology and explaining the game. For example, participants insisted on a more detailed portrayal of the climate conditions, as this would determine their harvesting strategies. Moreover, researchers were not always confident on how to handle some very inventive modifications that were proposed by the players during stage 3.

It is important to stress that the findings of this study although supporting several well-studied theoretical propositions, cannot be generalized, to all irrigation water users in Kyrgyzstan or in other settings. The authors further recognize the potential usefulness of process-oriented research design for engaging participants as the development of the "rules" could support or be driven by local power dynamics rather than a plain utilitarian objective. Explicitly dealing with issues of power and its different forms, as well as participation and conflicts across the stakeholder group would offer a complementary angle in any future analysis (similarly to [45]). However, due to the largely exploratory character of the current research in a rather insufficiently studied setting, the authors opted for an initial small and conservative research step rather than a leap ahead. It is suggested that future studies should focus more on the qualitative characteristics of the communities in questions, so as to explore further issues of conflicts and cooperative mechanisms, social cohesion, community identity, role of leadership, power and the influence of existing social networks.

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Author Contributions

Tanja Baerlein was leading author for the empirical part, the data processing and the overall editing and formatting, Dimitrios Zikos led the theoretical and conceptual part of the research and of the paper, including structural issues, development of the argument and general guidance, while Ulan Kasymov dealt predominantly with the analytical part of the paper and in situ field work support.

Conflicts of Interest

The authors declare no conflict of interest. The funding sponsor (VolkswagenStiftung) had no further role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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